U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1453

GROWING & PLANTING CONIFEROUS TREES ON THE FARM

CONIFEROUS TREES are especially well adapted for planting on the poor waste areas common to many farms. They grow fairly rapidly and yield heavy crops of timber. They are very effective as windbreaks. Even in small sizes they may in some localities be disposed of at a profit as Christmas trees and in large sizes they have an assured market for lumber or pulp wood.

This bulletin points out simple methods of collecting the seed, growing the trees in a small home nursery, planting them out in the waste places on the farm, and giving them the small amount of care subsequently desirable.

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GROWING AND PLANTING CONIFEROUS TREES ON THE FARM

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CONIFEROUS TREES (pines, spruces, firs, and the like) suitable for forest planting can not be grown from seed, as a rule, in less than two to four years; shortleaf pine, loblolly pine, and slash pine are often large enough in one year. If produced in a small nursery on the farm, a corresponding delay will ensue before the trees can be planted in the field. This may be an objection. To the majority of farmers who want to set out a few hundred or thousand such trees, therefore, the general advice of the Forest Service is to secure them from the State-operated nursery, if there is one (see Appendix, p. 37), or from a reliable commercial nursery.

It sometimes happens, however, that the kinds of trees desired can not be procured from either of these sources or the prices may be very high. Trees procured from nurseries, moreover, are not always in the best condition when received, especially if poorly packed or if shipped a considerable distance. Further, there are some distinct advantages in having home-grown trees: They will be on hand when wanted for planting in the field and will be in good condition. If for these or any other considerations a farmer desires to grow his own trees in a small home nursery, there is no good reason why he can not do so. It will require some time, attention, and labor, but the difficulties are not great.

There are two main steps in the nursery operation: (1) Procuring the seed, and (2) growing the trees in the nursery. Two other operations follow: (1) Planting the trees in the field, and (2) caring for the plantation. To assist those wishing to grow and plant a few conifers this bulletin discusses simple methods. Before embarking on the operation, however, the first thing is to decide upon the kind of tree that will suit the planter.

NOTE.—Acknowledgment is made to the State foresters of New York, New Hampshire, Vermont, Massachusetts, Pennsylvania, Virginia, Ohio, and Michigan for material that was of great assistance in the preparation of this bulletin.

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WHY GROW CONIFERS

There are several reasons why it is desirable to grow conifers (pine, spruce, fir, etc.) rather than hardwoods (elm, ash, oak, walnut, cottonwood, etc.). Probably the most important is that some species of conifers, the pines in particular, will ordinarily take hold and thrive better than hardwoods on poor soils, such as worn-out fields or pastures, sandy areas, cut-over and burned-over woodlands not restocking naturally, and areas with shallow soil. (Figs. 1, 2, and 3.) This is especially true when cultivation is not given the trees after they are set out. It should not be concluded that conifers grow best under such adverse conditions. Like any other soil crop, trees grow most thriftily on rich, deep, well-drained soils. While pines may live under conditions where other species are almost

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FIG. 1.—Ten-year-old western yellow pine plantation in the sand hills of Thomas County, Nebr.

bound to fail, their rate of growth will often be slow, sometimes disappointingly so.

With the possible exception of two or three species of hardwoods, nearly double the yield of saw-log material can be procured from a fully stocked merchantable stand of conifers than from a similar stand of equal-aged hardwoods. More coniferous trees can be matured to the acre and their upright unbranched trunks make it possible to saw three to five 12-foot logs from each tree in a 50 or 60 year old stand, while two or two and one-half logs is more nearly the average for hardwoods of the same age. Where a large yield of timber is the primary object, therefore, conifers are generally preferable to hardwoods.

There are other reasons for giving preference to conifers: they are ornamental in winter as well as in summer; and as windbreaks they are much more effective the year round than hardwoods.

CHOICE OF TREES

The trees chosen should be determined by the object of planting, by their adaptability to the climate and soil of the region, and by their resistance to serious diseases or to insect attack. It would be foolish, for instance, to grow for saw timber Virginia pine (often also called scrub pine and spruce pine) in those parts of Maryland where shortleaf and loblolly pines, both much more valuable commercial species, can be grown just as easily. No attempt should be made to grow southern longleaf and slash pines in the Northern States, since they would be killed by the severe winters. It would generally be inadvisable to grow spruce or fir on poor, sandy lands where the climate is suitable for pines. The latter will develop much better on these soils. If he expects to grow white pine a prospective

F-62073

FIG. 2.—Ten-year-old red pine plantation in Itasca County, Minn. Red pine is one of the best species for that region

planter should realize the danger from white pine blister rust and be prepared to take the measures necessary to combat it.

The eastern red cedar should not be planted anywhere near apple orchards because the disease known as cedar rust spreads from this tree to the leaves and fruit of apple trees.

The map (fig. 4) indicates some of the conifers which seem adapted for planting in the districts outlined. This does not mean that all the species listed in any one district can be grown in all parts of it or under all conditions of soil existing there; neither does it mean that other trees may not be suitable. In Nebraska for instance, Jack pine is adapted only to sandy soils in the western part of the State and even there may be killed by droughts of long duration. For climatic reasons, the Pacific coast form of Douglas fir is not suited for planting in eastern Oregon and Washington; it is necessary to procure Douglas fir trees that have been grown from seed

collected east of the Cascade Mountains. There is yet much to be learned about these matters through experience. *In choosing the tree or trees, the safest rule is to select those which occur naturally*

F-22230

FIG. 3.—Fourteen-year-old jack pine plantation in sand hills of Holt County, Nebr. Trees are 12 to 24 feet high

on a similar situation in the region or have been grown there successfully. If there is no such guide, it is best to write the State forestry department and secure advice in the matter. (See list of State forestry departments in the Appendix, p. 37.)

RATES OF GROWTH

Information concerning the rates of growth of coniferous trees is available for some species and may be of help in determining

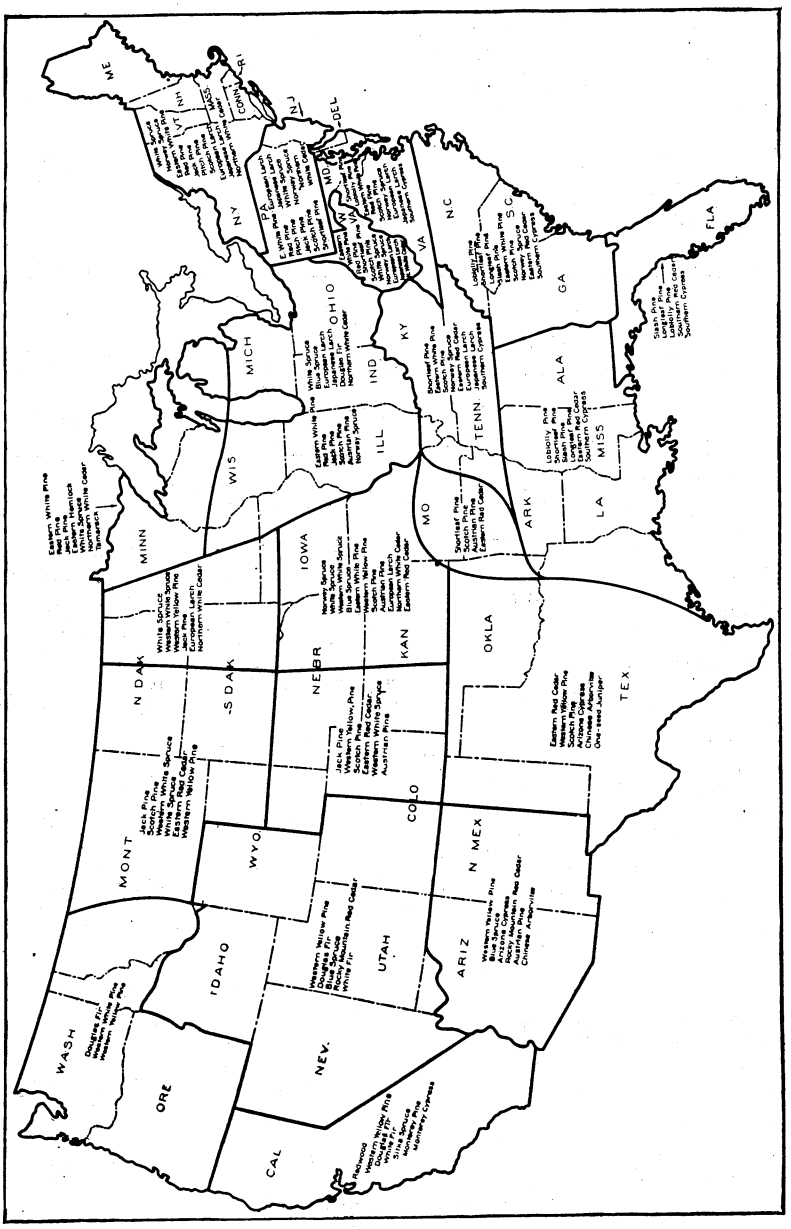

FIG. 4.—Some coniferous trees suitable for planting on farms, by regions

the choice of those to be planted. Rough figures for trees in the forest are given in Table 1. These figures are not equally applicable over the wide range of territory in which a given species can be

grown and under the great variety of climatic and soil conditions encountered. For comparative purposes, however, they will serve fairly well. Growth appears very slow for some species. Trees will commonly make more rapid growth in a plantation than in a natural forest, because they are usually less crowded and are not shaded in youth. Trees planted in windbreaks two or three rows in width make considerably faster growth than those planted in solid blocks, because they have an abundance of sunlight and growing space.

TABLE 1.—*Number of years it takes trees in forest stands to grow 1 inch in diameter*

Years	Species	Years	Species
2 to 3	Redwood.	4 to 8	White spruce.
3 to 4	Douglas fir (of the Pacific coast).	4 to 15	Eastern red cedar.
3 to 5	Southern cypress, loblolly pine, shortleaf pine, slash pine.	5 to 6	Norway spruce.
3 to 7	European larch.	5 to 7	Sugar pine, western white pine.
4 to 6	Scotch pine, Virginia (scrub or spruce) pine, Sitka spruce.	5 to 12	Western yellow pine, hemlock.
4 to 7	Jack pine, longleaf pine, red pine, eastern white pine.	6 to 8	Red spruce.[1]
		7 to 12	Balsam fir, incense cedar.
		8 to 15	Douglas fir (of the Rocky Mountains), lodgepole pine.

[1] Old pasture stands.

PROBABLE YIELDS

Not many figures are available concerning yields from plantations. A study[1] of older plantations in Massachusetts a number of years ago revealed that some of these had made very good growth (fig. 5). Yields per acre of 17,000 board feet in 36 years, 24,000 feet in 39 years, 33,000 feet in 43 years, 32,000 feet in 46 years, 35,000 feet in 50 years, 44,000 feet in 55 years, 38,000 feet in 56 years, and 44,000 feet in 60 years are recorded in eastern white-pine plantations. A mixed 48-year-old plantation of eastern white pine and Norway spruce contained 33,000 board feet per acre (fig. 6).

A few species, such as redwood and Douglas fir of the Pacific coast, should yield more than white pine under average conditions. Others will yield less. Given good care on fair soil in their native region, the more valuable species of conifers grown in the plantations on farms should yield 10,000 to 25,000 board feet to the acre at an age of 50 years; in many cases, a great deal more.

TREES FOR WINDBREAKS

Trees which have dense foliage that is retained over winter and whose lower branches hang on for a long period of years are the best for windbreaks. These are spruces, firs, hemlocks, Douglas fir, arborvitæs, cedars, and Monterey cypress. The white pines are nearly as good, and Scotch pine is very effective up to 12 or 15 years of age (figs. 7, 8, and 9).

PLANTING EXOTICS

By exotics is meant trees which are not native to a region. This may include trees not only from Europe, Asia, or other foreign

[1] J. R. Simmons, The Older Forest Plantations in Massachusetts—Conifers.

countries, but from distant parts of the United States. For instance, Douglas fir, which is native to the Rocky Mountains and Pacific coast regions, is just as much of an exotic to the eastern United States as is Scotch pine, which is native to Europe. Ordinarily the planting of exotics in large numbers is inadvisable unless vigorous-growing trees in the immediate region prove that the species will succeed. Catalogues, the word of interested agents, advertisements, or newspaper articles are not sufficient evidence of the worth of such trees. Extensive planting of untried exotics is more than likely to lead to loss of trees, time, and money, and to consequent disappointment. It is a safer plan to use those native species which are so good that they have made their own reputation

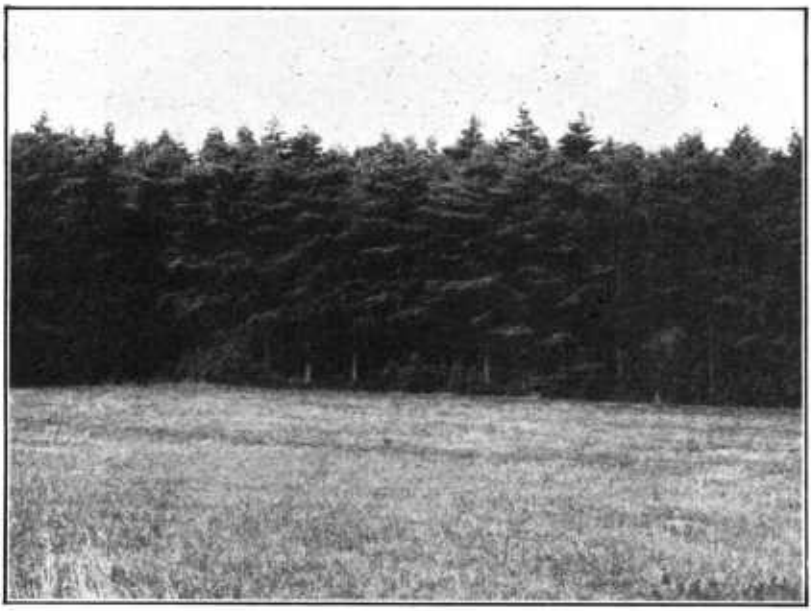

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FIG. 5.—Plantation of white pine at East Bridgewater, Mass., started in 1875 with trees taken from a pasture. It was cut 47 years later, and yielded 33,000 board feet to the acre

and do not need to be advertised. A few European conifers widely introduced into the eastern part of the United States have done very well. The most common of these are Scotch (fig. 10) and Austrian pines, Norway spruce, and European larch (fig. 11). Japanese larch, Japanese red pine, and Japanese black pine are promising species for some localities. It has not yet been demonstrated, however, that these are generally superior to, even if they are as good as, some of the native trees. Scotch pine has shown great ability to grow well during youth upon some of the poorest bare, sandy soils, blow sand in particular, in the eastern United States. (Fig. 10.) Norway spruce (fig. 6) grows more rapidly than our native eastern spruces, at least up to 50 or 60 years of age.

PLANTING TWO OR MORE KINDS OF TREES IN MIXTURE

There is not enough known in regard to planting our native trees in mixture to justify recommendations. A few young plantations indicate that red pine and eastern white pine or Norway spruce and eastern white pine may safely be planted in mixture. European larch in combination with eastern white pine or Norway spruce also

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FIG. 6.—Forty-eight-year-old Norway spruce and white pine plantation near Georgetown, Mass., which if cut would yield 33,000 board feet to the acre

appears to be a good mixture. In such a combination, about one-third of the trees should be larch and two-thirds pine or spruce. Doubtless other combinations will succeed, but mature plantations in this country which prove what species may successfully be mixed in plantations are unknown to the writer.

A row of northern white cedar (arborvitæ) backed up by a row or two of spruce or pine is a very effective combination for a windbreak.

UNDERPLANTING OLD STANDS OF TREES

If an owner wishes to plant under scattered old limby trees, the best conifers for the purpose are firs, hemlocks, and spruces. Even these species will not grow rapidly if planted in deep shade. Such underplanting is not recommended, therefore, unless the trees are set in openings where they will not be shaded much or unless the old trees are to be removed within three to five years.

PROCURING THE SEED

Seed can be collected from trees in the locality or purchased. When inexperienced labor is employed to collect and extract seed, it is likely to cost as much or more than if purchased from a seed

F-16217

FIG. 7.—Interior of a Norway spruce windbreak on an Iowa farm which affords almost perfect protection against wind

dealer. Even so, there will be the certainty of its being fresh and of local origin.

Before procuring seed from any source, something should be known about the yield of clean seed from a bushel of cones and the approximate number that will sprout in a pound. (Table 2.)

This information is not available for all species, and the figures given should not be taken as absolute, since they are subject to considerable variation.

COLLECTING THE SEED

The seed of coniferous trees is inclosed in the cones or "burs" (figs. 12 and 13), which are borne for the most part toward the tips of the branches or, in the case of the spruces, mainly near the very

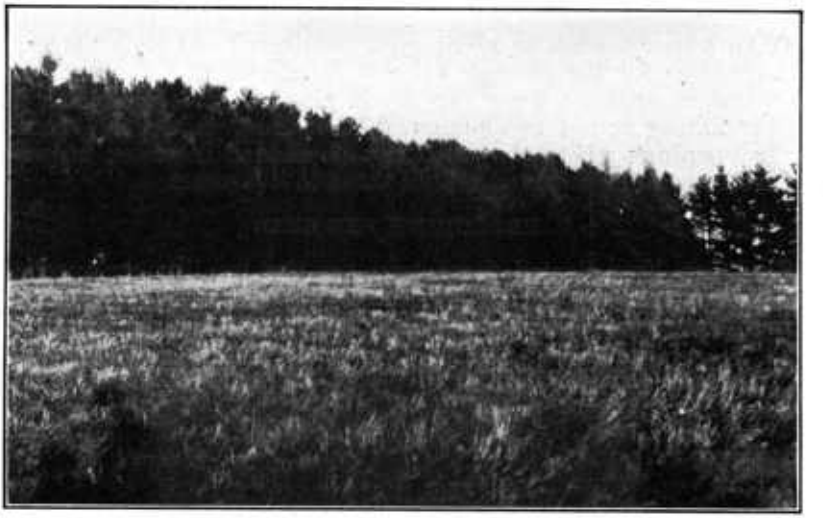

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FIG. 8.—Forty-year-old windbreak of white pine and northern white cedar in Fayette County, Iowa, 55 feet high. This is a splendid combination for a windbreak

tops of the trees. To obtain the seed, it is necessary to collect the cones before they become so ripe on the tree that the scales open and permit the seed to fall out. In the case of the true firs, the cones actually fall to pieces on the trees when they become thoroughly ripe.

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FIG. 9.—Monterey cypress windbreak. San Diego County, Calif.

F-151983

FIG. 10.—Young plantation of Scotch pine on a hill of bare, shifting sand. Trees are making a height growth of 2 feet or more a year. Lyndon, Vt.

F-19062

FIG. 11.—Twenty-seven-year-old European larch plantation in Kane County, Ill.

TABLE 2.—*Information about forest tree seed*

Species	Pounds of seed per bushel of cones	Number of seed per pound	Number of seedlings 1 pound of seed will produce	Ounces of fresh seed to sow per 100 square feet of seed bed to produce 100 seedlings per square foot
Northern white cedar		280,000	12,000–30,000	5–13
Chinese arborvitæ		25,000		
Western red cedar	1.5	400,000	26,000	6
Incense cedar	2.5–3	17,000		
Eastern red cedar	.75	17,000	6,000	
Southern white cedar		470,000		
Arizona cypress		100,000		
Southern cypress		7,500		
Monterey cypress		58,000		
Douglas fir	.4–1.25	45,000	16,000–20,000	8–10
Balsam fir		35,000	5,000	32
Noble fir	2.5	17,000	1,500–2,500	64–106
White fir	3	12,000		
Eastern hemlock		300,000	4,000–6,000	27–40
European larch		60,000	5,000–10,000	16–32
Japanese larch		110,000	7,000–16,000	10–23
Western larch	.5–0.9	150,000	15,000	11
Austrian pine		24,000	7,000–10,000	16–23
Jack pine	.5	150,000	15,000–35,000	5–10
Japanese black pine		48,000	24,000	6⅔
Japanese red pine		52,000	35,000	5
Loblolly pine		20,000		
Lodgepole pine	.35–1	80,000		
Longleaf pine	1	6,000		
Monterey pine		20,000		
Pitch pine		55,000	11,000	15
Red pine	.5–1	54,000	20,000–35,000	5–8
Scotch pine		70,000	8,000–14,000	12–20
Virginia pine		60,000		
Shortleaf pine		45,000	22,000	8
Slash pine		18,000		
Sugar pine	1.6	2,400		
Western white pine	.3–.75	28,000	8,000	20
Eastern white pine	.7–1	26,000	8,000–14,000	12–20
Western yellow pine	.7–2	9,000–16,000	2,500–5,000	32–64
Redwood		160,000		
Blue spruce	1	80,000–130,000		
Engelmann spruce	.5–1	175,000	15,000–40,000	4–11
Norway spruce		60,000	14,000–35,000	5–12
Red spruce		130,000	16,000–25,000	7–10
Sitka spruce	1.25	100,000	30,000–40,000	4–6
White spruce	.5	180,000	14,000–20,000	8–12

NOTE.—The figures in the above table are not absolute; they may vary more than table indicates.

WHEN TO COLLECT

No definite time can be set for the collection of cones. Although they sometimes begin to ripen the latter part of August, even in mid-October they may not be too far opened for collecting from the trees. Some of the cones of certain pines remain closed for years and may be collected at any time while in that condition. On the other hand, it is useless to collect after the cone scales have opened widely, because the greater part of the seed will have fallen out. One of the safest ways to judge whether cones are ripe is afforded by the actions of squirrels. Coniferous-tree seed is a favorite winter food of squirrels. When the seed is ripe, these animals cut the cones from the trees and store them away. It is safe, therefore, to commence collecting as soon as the squirrels do so.

Another test of ripeness is to cut into a cone and examine the seed. If the kernel is full, plump, and white, but not milky, the seed is

ripe. Often the cones will still be greenish in color, or just starting to turn purple or light brown when the seed is fully mature.

WHERE TO COLLECT

Fresh seed from local sources is generally considered preferable, since trees grown from it are almost certain to be hardy. Cones should be collected from newly felled or standing, vigorous, healthy, middle-aged trees; seed from runty or diseased specimens, over-aged, or very young trees is likely to be no good. Although trees growing in the open usually produce cones in greater quantities than those in dense stands, those newly felled in logging operations are one of the most prolific and best sources of cones.

HOW TO COLLECT

Cones can be readily picked by hand from felled trees. It is not so easy to pick them from standing trees. Some people climb the trees in order to reach the cones (fig. 14); others use ladders. Sometimes branches laden with cones are cut off and thrown to the ground, where the cones can be picked without difficulty. This practice disfigures the trees and greatly reduces their future cone-bearing ability, and should not be followed if it can be avoided. Long-handled tree-pruning shears or sharp hooks can sometimes be used to advantage in cutting the cones from the trees. Collecting is often a very sticky, disagreeable task because of the resin on cones, leaves, and twigs. The collector needs a bottle of kerosene which can be used frequently to cleanse the hands.

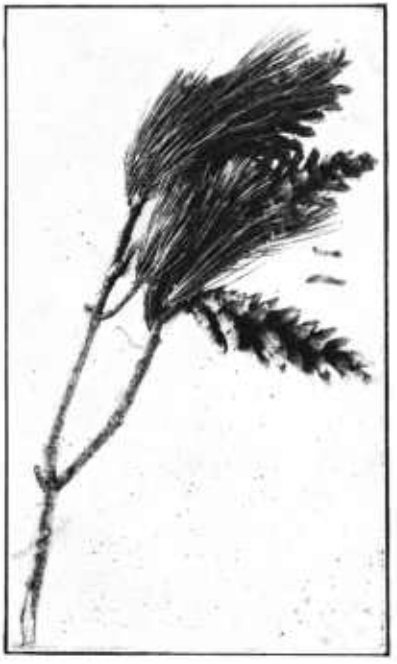

FIG. 12.—A white pine branch showing opened cones from which the seed has fallen. Two seeds with the wings attached are shown to the right

Squirrels store cones around old rotten logs, among the roots of trees, along streams, beneath overhanging stream banks, and in similar situations. (Fig. 15.) One or two bushels are commonly stored in one place, and hoards up to 40 bushels have been found. One or two bushels of cones is ordinarily a good day's collection from standing trees; from squirrel hoards it is often possible to collect several times this quantity. Another advantage of collecting from squirrel hoards is that the cones remain damp and closed and can be gathered after those attached to the trees have opened.

CARE OF CONES

Fresh unopened cones are somewhat moist. If closely packed together for some time they are likely to heat and mold, with conse-

quent damage to the seed. To avoid this the seed should be extracted within a few days or the cones spread out to dry three or four deep in well-ventilated bins or boxes. This is an important precaution.

EXTRACTING THE SEED[2]

OPENING CONES BY SUN HEAT

A practicable method of extracting seed for the man who has collected a relatively small quantity of cones consists in spreading

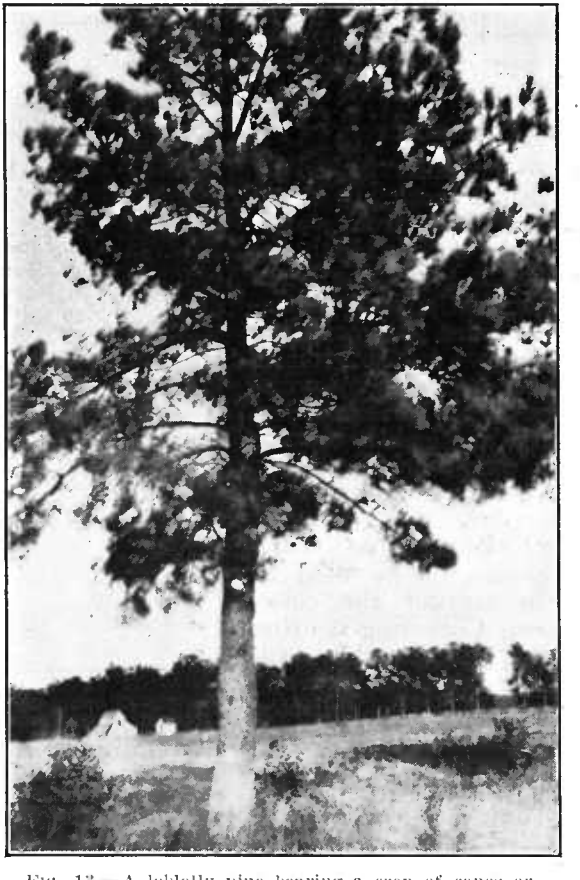

FIG. 13.—A loblolly pine bearing a crop of cones or "burs." The seed is found within the cones

the cones out thinly on cloth or on a flat roof and exposing them to the sun's heat until the cone scales open and spread out. This may take several days even in fair weather, and still longer in weather which is intermittently rainy and bright. The drying will be hastened if the cloth is spread on a platform of boards rather than on

[2] For more complete discussion, see Forest Service Circular 208, Extracting and Cleaning Forest Tree Seed. Available by purchase from Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents.

the moist ground and if the cones are occasionally turned over so as to expose all surfaces to the sun's rays. (Fig. 16.) Lodgepole and jack pine cones, as well as some others, can not be opened this way; they need the application of artificial heat. The cones should be covered each night to protect them from rats, mice, or other night-prowling rodents.

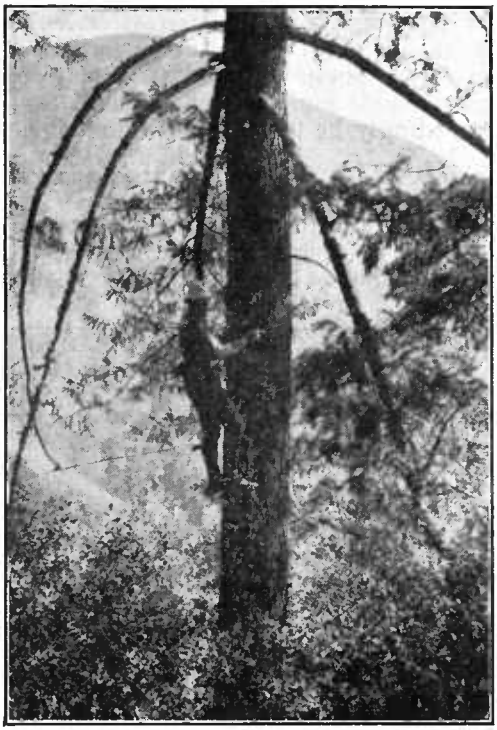

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FIG. 14.—Climbing tree to collect cones. Although this is slow and laborious, sometimes it is the only way by which cones can be obtained

OPENING CONES WITHOUT HEAT

Some kinds of cones will open at the ordinary temperatures if given time enough. They can be spread out two or three deep on the floor of a shed or granary and left until they open. They open somewhat more rapidly if raked over each day. In such places, however, many of the seed are likely to be eaten by mice or other rodents.

If there is only a small quantity of cones to deal with they can be placed in boxes or baskets and set in the kitchen back of the stove. The heat from the stove will hasten their opening considerably.

OPENING CONES BY ARTIFICIAL HEAT

This method involves considerable preparation and special equipment, and will be touched upon only briefly.[3] To dry cones by artificial heat, a shelter such as a tight-walled building, room, or tent is commonly employed. A tight shed will do. A stove, furnace, or steam pipes can be used to heat it to a temperature of 110° to 150° F. Stoves are not very satisfactory, because they do not distribute heat constantly and evenly, and tents are not tight enough to retain the heat well. Trays which will hold one-half to 1 bushel of closed cones are ordinarily provided, and racks on which to place them are built in the shelter. The bottoms of the trays should be slatted or constructed of wire netting, so that the air can circulate freely and the seed can fall through to the floor. Ventilation must be provided, in order that the moisture driven from the cones as

[3] See footnote 2.

they are heated will escape from the shelter and be replaced by dry air from the outside. By gradually shifting the trays from the racks at low levels, where the heat is less intense, to those at higher levels, where the heat is greater, cones can be opened in 10 to 15 hours (fig. 17). Opening is hastened if the cones are stirred frequently. Shelters used for seed extraction become very dry and inflammable and frequently catch fire. Adequate precautions must accordingly be taken against fire during the extraction process.

SHAKING OUT THE SEED

During the drying process a portion of the seed will fall out of the cones. A great many will stick to the cone scales, however, and will have to be loosened by shaking or jarring. Vigorous raking of the cones after they are well opened will sometimes dislodge a fair proportion of seed. A greater proportion can usually be obtained by shaking the opened cones vigorously for a period of 5 to 10 minutes in a shaking device. A simple piece of equipment is a box or tray, the bottom of which is constructed of slats spaced one-half inch or more apart or of meshed wire fine enough to prevent the cones from falling through. (Fig. 18.) It should be filled about half full of opened cones and shaken vigorously. The seed will be dislodged and sift down through the openwork bottom.

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FIG. 15.—Gathering cones from a squirrel hoard. Quantities up to 40 bushels have been taken from one hoard

A homemade churn shaker is an effective device, easy to make and to operate (fig. 19). It is a strong box about 3 by 3 by 4 feet (or some similar dimension which will not be too heavy to operate), with an iron or heavy wooden axle through its longitudinal center and a handle by which it can be rotated. The shaker is held up by the axle resting at the ends upon vertical supports, such as sawhorses or posts set in the ground. At least two sides of the box should be of slat or woven-wire construction, to allow the dislodged seed to fall out. One side of the box should be hinged, so that it may be opened to receive the cones and to discharge them after shaking. A barrel, the ends of which are screened with wire or slats, can be substituted for the box if it is more readily available.

The shaker should be turned rapidly enough to agitate the cones violently. Increased effectiveness results if medium-heavy blocks of wood are placed inside to rattle around with the cones and increase the jarring. If too heavy, these blocks will break the cones and crush some of the seed, thus increasing the chaff which will have to be screened out later.

All the cones will not open fully by any method of drying, and all the seed will not be dislodged by shaking. The best seed, however, will usually fall out. It will not pay to spend too much time trying to get all the seed or even the last 10 per cent.

CLEANING THE SEED

Cleaned seed is easier and more agreeable to handle than uncleaned seed. There is no real need for cleaned seed in a small home nursery, however, except that when the seed is clean it is easier to calculate the amount to sow in a bed. The thorough cleaning of coniferous forest-tree seed involves the removal of dust, cone scales, needles, and other forms of chaff, the separation of the wings from the seed itself in many cases, and the separation, so far as is practicable, of empty seed from those with a kernel.

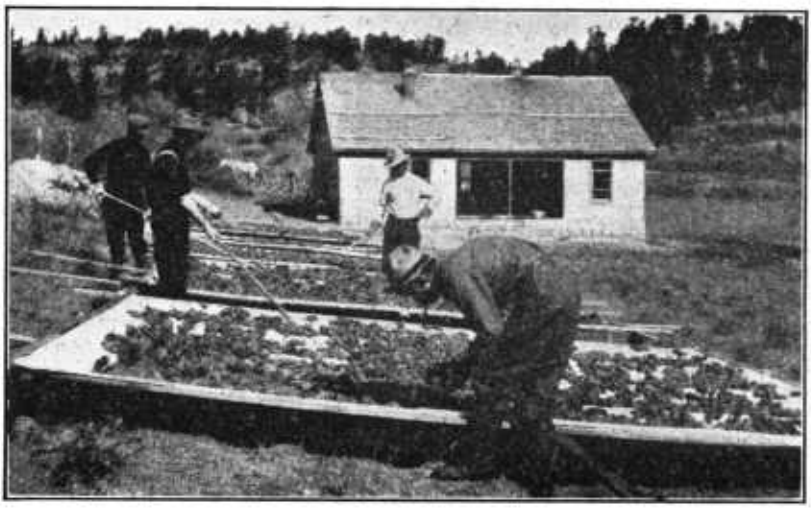

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FIG. 16.—Pine cones spread out in the sunlight to dry and open

A great deal of the dirt and chaff mixed with the winged seed can be removed by using several screens of various-sized mesh. The material smaller than the seed can be removed by using fine screens, while the larger can be disposed of by sifting the seed through screens which will retain the coarser stuff.

REMOVING THE WINGS

Commercial seed establishments usually remove the wings of coniferous seed such as pine, spruce, and larch, which are not firmly attached to the seed itself or do not form an integral part of the seed coat. This is not necessary in seed collected for home use. The sprouting capacity of the seed is not improved by removing the wings. It is easier to handle and is worth more commercially. They can be removed by rubbing the winged seed through screens with a mesh slightly larger than the bare seed. The gloved hands, a stiff brush, a piece of carpet, or something similar can be used in

this process. The seed should not be crushed. Another simple process is to place the seed in a sack and work it over with the hands or beat it with light flails. Neither of these methods is more than partially effective. They are more effective with pine and spruce if the seed is slightly moistened and allowed to stand in that condition for several hours before it is worked over. Such moistened seed must be thoroughly air-dried after the wings are removed.

F-18111-A

FIG. 17.—Interior of a seed-extracting plant. Handling a tray of cones

THE FINAL CLEANING

After the seed has been put through screens, considerable quantities of broken seed wings, light empty seed, twigs, resin, and other foreign matter will still be mixed with it. A portion of this material can be removed by winnowing. When a light breeze is blowing, the mixture of seed and chaff should be poured slowly from a box held at a height of 3 or 4 feet above the ground into another box placed on the ground. The height should vary with the strength of the wind. As the mixture falls, the wind will carry the lighter chaff away, while the heavy good seed will drop in the box below. By repeating this process several times, fairly clean seed can be procured.

In commercial operations, fanning mills are used to clean seed. Since such mills will seldom be found on farms, their use will not be discussed.

STORING THE SEED

When coniferous seed is not sown the same fall it is collected it can be stored in cloth or paper bags over winter. Heavy paper bags are preferable to cloth. The seed should be placed out of reach of rats, mice, and other rodents, and will keep better where the temperature is continually at the freezing point or lower. Seed of the true firs or balsams should be sown in the autumn as soon as collected, or, if necessary to keep it over winter, it should be mixed with moist sand or earth and stored in a cold place. Pine, Douglas fir, and spruce seed will keep best if, after being sufficiently dried to remove all moisture from the outer coating, it is placed in a dry and air-tight receptacle. If stored in this manner these seed will still be good after several years.

GROWING THE SEEDLINGS IN THE NURSERY

LOCATION OF NURSERY

As a matter of convenience in handling, the nursery should be near the dwelling. To grow healthy, vigorous trees it should be located where the land is reasonably level and the soil fertile, well-drained, and deep. A sandy loam soil is preferable. Soil that will grow a satisfactory crop of vegetables will ordinarily grow good trees. The nursery should, if possible, be within reach of a sprinkling or irrigation system, because water is essential for satisfactory results.

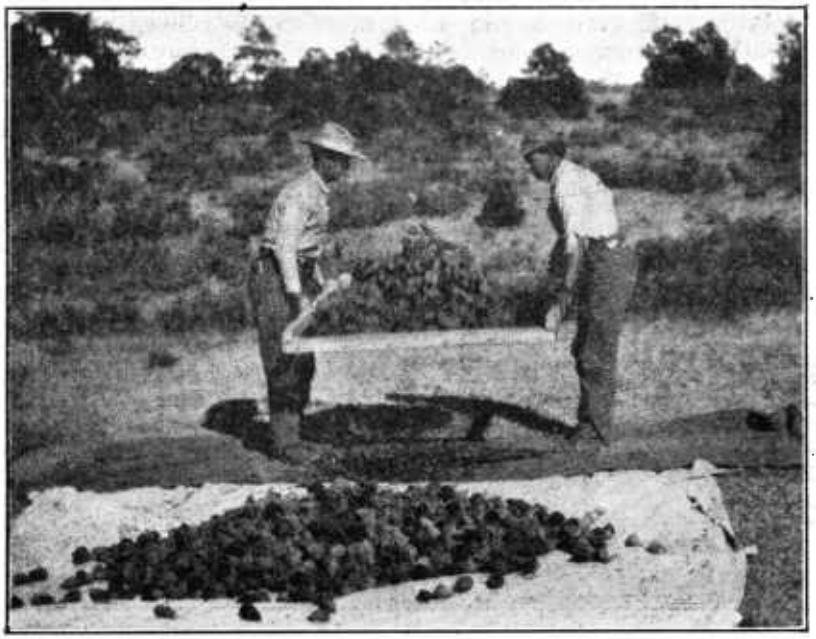

FIG. 18.—Shaking pine cones to jar the seed from them. Cones have been opened by exposing them to the sun

PREPARATION OF SOIL

The soil should be prepared with as much or even more thoroughness than for a vegetable garden. It should be spaded or plowed to a depth of a foot and all roots, rocks, or other trash removed. It should then be finely pulverized with a harrow or hand rake. The seed beds in particular should be put in a very fine state of tilth. It is a common practice to lay off seed beds 4 feet wide by 12 feet long, raised slightly so as to insure good drainage. In one bed of this size about 4,000 to 8,000 seedlings can be produced. The number of beds prepared will depend upon the number of trees that the owner wishes to grow. After the beds are laid out it is a good, although not essential, practice to roll or tamp them so as to firm the soil and smooth out irregularities.

TREATMENT OF SEED TO HASTEN GERMINATION

Coniferous seed does not always sprout readily. If it is to be sown in the spring, soaking it in water for about a week just previous to sowing is often recommended.

Eastern red cedar and presumably the other red cedars require special treatment, for the seed is inclosed in little blue or black berries which are pulpy and resinous. If sown without some treatment, the seed often does not sprout until the second spring or summer after sowing. It is desirable, therefore, to remove this pulpy substance before sowing the seed in the fall. Some nurserymen do this by running the berries through a meat grinder, the teeth of which are coarse enough not to crush the seed. Others soak the berries in water until the pulpy substance can be rubbed off between the hands, by means of brushes, or in any other way that will not

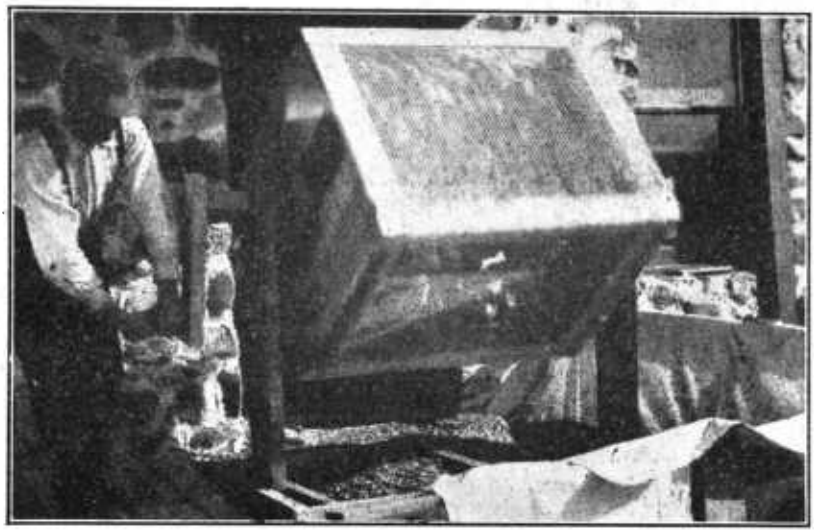

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FIG. 19.—Churning the dried cones to loosen the seed. Note that the seed is being shaken out and is falling through wire mesh to the ground

crush the seed. The good seed will sink in the water, while the poor seed and a good part of the pulpy substance will float and can be skimmed off. The good seed should be sown at once at a depth of about one-half inch and the bed mulched with leaves or straw, or it may be stored in moist sand in a cold place over winter and sown early the following spring. In either case it usually sprouts satisfactorily.

Another method which is said to have been used with success is to place the berries in a gunny sack and bury them in a manure vat over winter. The action of the heat and chemicals is such as to eat off the pulp, and germination follows readily when the seed is sown the following spring.

If the berries are mixed with moist sand in a box and buried out of doors from one fall until the second spring and then sown in beds, the seed will usually sprout freely.

SOWING THE SEED

SEASON

Coniferous seed can be sown either in the fall or in the spring. Some thin-shelled coniferous seed like that of the firs loses its vitality quickly. Longleaf-pine seed also appears to have this characteristic. The seed of eastern white pine, western white pine, sugar pine, eastern red cedar, the Pacific coast form of Douglas fir, and possibly others often does not sprout readily, particularly if the seed is old or has been improperly stored. Better results are ordinarily obtained from fall sowing of all such species. With other species, spring sowing is usually satisfactory, provided the seed has been properly stored over winter.

QUANTITY OF SEED TO SOW

The amount of seed to sow to a bed will be governed by its quality and by the number of seedlings which the owner wishes to produce. If procurable, only fresh seed of good quality should be sown; old seed is apt to be of little worth. An indication of the quality can be obtained by cutting 200 or 300 in halves and noting the condition of the kernels. If the kernels are for the most part white, plump, and greenish or yellow in the center, the seed should be good, although this is by no means an unfailing sign. A better method is to test the seed by sprouting a few on moist cloth or in moist sand in the same manner that corn or wheat is now very commonly tested before it is sown. The test should be started 60 days before the seed is to be sown, because some kinds of seed are very slow to sprout. Such a test will not always give a true indication of the percentage that will sprout in a nursery bed, since the germination in a sprouting test is usually higher. Nurserymen of considerable experience claim that 1 pound of fresh seed will produce approximately the number of seedlings indicated by Table 2.

METHOD OF SOWING

Coniferous seed can be sown in drills in much the same way that lettuce or radish seed is sown, or it can be scattered broadcast over the bed. The drills should be 4 to 6 inches apart and one-fourth to one-half inch deep. Small seed should be given a shallow covering; large seed a deeper one. In drill sowing the seed can be covered to the proper depth of one-fourth to one-half inch by filling the drills level full with soil after sowing. In broadcast sowing an easy way to cover the seed is to sift soil or sand over it through a wire screen of about one-fourth inch mesh. Sand is better than soil, because it sifts more easily and if clean usually contains very much less weed seed.

NUMBER OF SEEDLINGS TO GROW TO A SQUARE FOOT

In good soil 100 to 150 coniferous seedlings can be grown to a square foot of seed bed, provided they are not to be left beyond the age of 2 years (fig. 20). If the soil chances to be poor, infertile sand, or if the trees are to be left three or four years in the beds, this number had better be cut to 60 or 75. The amount of seed to

sow to 100 square feet of seed-bed surface in order to produce 100 seedlings a square foot should be about as indicated in Table 2.

CARE OF SEED BEDS

COVERING THE BEDS

If seed is sown in the fall of the year and is not likely to sprout until the following spring, it is advisable to cover the beds with some material that will keep the seed from being washed out by heavy rains, heaved out by alternate freezing and thawing of the soil, or blown out by exceptionally severe winds. A single thickness of burlap or an inch or two of straw, hardwood leaves, pine needles, or hay may be used for the purpose. Hay is the least desirable cover, since it is likely to bring a good many grass or weed seeds to the

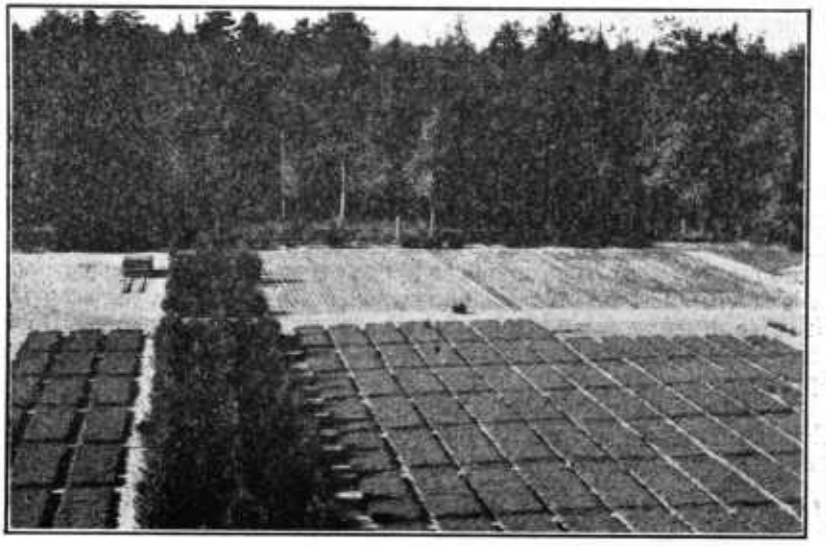

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FIG. 20.—A Michigan State nursery. In the foreground are beds containing 1 or 2 year old seedlings. Note how thickly they can be grown in a bed. Back of the nursery beds are small trees which have been transplanted in long rows. The five rows of trees to the left of center serve as a windbreak

beds which will later sprout and cause trouble. Rice straw is very good. Any of these must be held in place by sticks or light brush until the following spring. The cover should be removed as soon as the seed begins to sprout.

WATERING

The seed beds should be watered when the soil is dry, first to induce sprouting of the seed and later to prevent the dying of the seedlings from lack of moisture. The beds should not be water-soaked, but should be kept just moist enough to insure good growth. Excessive moisture is not desirable, because it keeps the soil cold and sometimes makes conditions favorable for the development of a disease, "damping off," which is very destructive to young seedlings.

SHADING

During their first summer and especially during the first six or eight weeks of their life coniferous seedlings are tender and liable to serious injury from the sun's heat. The surface of the soil often becomes extremely hot on bright, warm days, and the tender stems are virtually cooked. The spruces, firs, cedars, and hemlocks are perhaps the most susceptible to injury of this kind, although any species may be affected. Shading of the beds is the means of prevention. Moreover, if it is out of the question to water the beds, shade will supplant water to a limited extent. Shaded soil will not dry out so rapidly as unshaded, and in consequence the plants will suffer less from lack of moisture. On cloudy days or when the air is cool shade is not necessary. It is most needed during the several hours of extreme heat in the middle of bright, hot summer days.

Shade can be provided by any rough means that comes to hand. One simple method is to drive short pieces of 2 by 4's at 10 or 12 foot

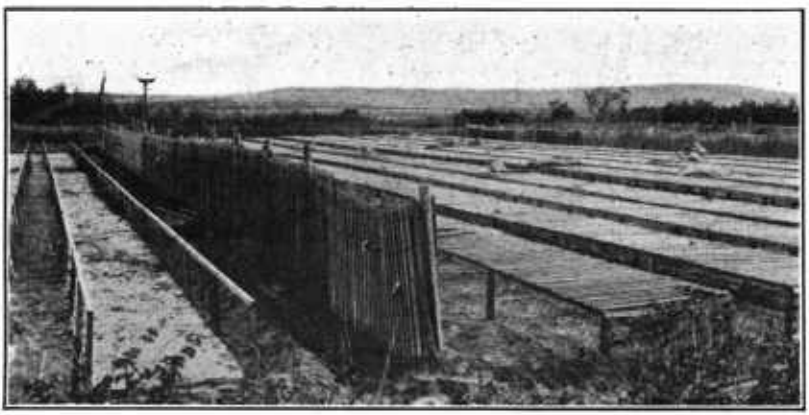

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FIG. 21.—This type of shade frame is easy to construct. Brush can be used in place of lath to shade the seedlings

intervals along both sides of the beds until their tops rest 16 to 20 inches above the surface. Each line of posts should then be connected at their tops by 1 by 4 stringers. This makes a framework upon which brush, boards, or other material that will cast a shade can be piled (fig. 21). A lath frame like that shown in Figure 22 is commonly used in large nurseries.

In their second and third years in the beds, coniferous seedlings are less liable to injury from sun or drought. Shade is then less necessary, particularly for pines. All seedlings should be carefully observed, however, and if damage is evident and water is not available, shade should be provided.

PROTECTION

The seed beds must be fenced against poultry and livestock. Mice may dig up and eat the seed, and birds often cause trouble by picking off the tops of the seedlings shortly after the seed sprouts. Both mice and birds can be kept out of the beds by use of the protective

screen illustrated in Figure 22. To be effective against mice, the wire hardware cloth used in its construction should be of one-half inch mesh or less. Traps can be used for mice and one or two house cats usually afford some protection against them.

Damage from early fall and late spring frosts must be guarded against by covering the beds on frosty nights in the same way that vegetables are covered. The shade frame is usually a fairly effective protection under such conditions.

On heavy soil, 1-year-old seedlings may be heaved out of the beds by frost. On light soils in regions of cold winters but little snow, the small trees may be killed by winter drying. Where either danger is known to exist or is probable, the beds should be mulched lightly with pine needles, hardwood leaves, or straw, or the shade

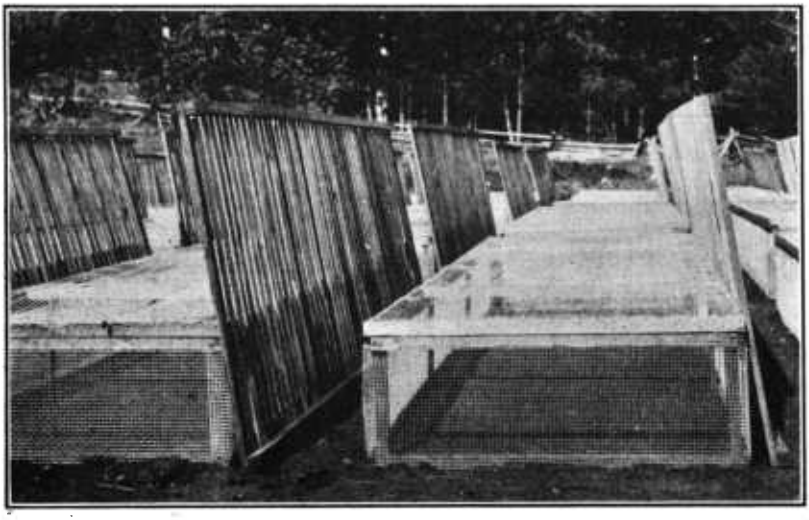

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FIG. 22.—This type of frame affords seed and seedlings protection against birds and mice as well as against sunlight

frames may be left on all winter. Care must be exercised not to overmulch, because the leaves or other material may become soggy and packed and smother the small plants. The mulch should be removed just as early in the spring as the weather permits.

"Damping-off" is a disease which attacks seedlings during the first few weeks of their life. It causes the stems to turn watery and limp, and the plants to fall over. In some large nurseries, a greatly diluted solution of sulphuric acid is used to combat the disease; in others, formaldehyde has been found more satisfactory. Covering the seed with clean sand rather than soil seems to be a partial preventive. The seed beds should not be fertilized with fresh manure, wood ashes, or lime.

WEEDING

To promote the best growth of the seedlings, the beds should be kept free of weeds. Weeding by hand is essential if the seed is sown broadcast. Garden tools may be used if the seed is sown in drills.

An application of 1⅛ ounces of zinc sulphate diluted in 1 gallon of water to each 4 square feet of seed bed immediately after sowing effectually killed weed seed in one nursery and proved in no way injurious to the seed or seedlings of western yellow pine and western white pine produced there. It is not known whether such an application would damage other species.

TRANSPLANTING

By transplanting is meant the transfer of the seedlings from the seed beds to other beds, where the small trees are set out 2 or 3 inches apart in rows 4 to 6 inches apart. The object of transplanting is to retard the growth of the tops and stimulate root development. The result is usually a compact, bushy top and a much-branched, fibrous root system. (Fig. 23.)

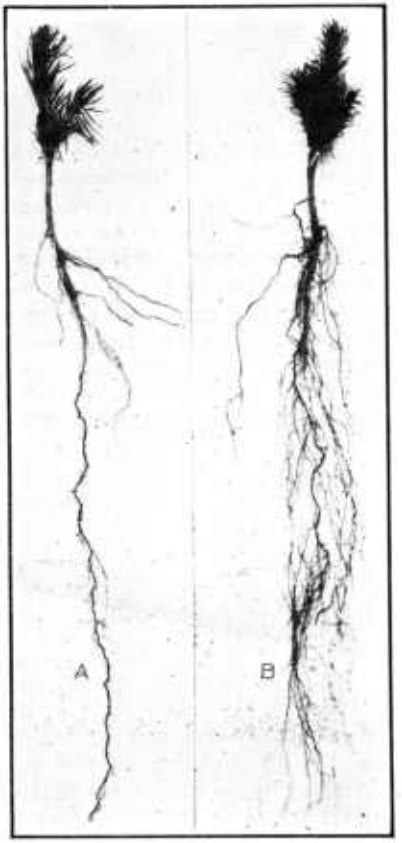

FIG. 23.—(a) Three-year-old Engelmann spruce seedling; (b) 3-year-old Engelmann spruce transplant. Note the greater quantity of fine roots of the transplant. For this reason transplants are usually better than seedlings for planting where conditions are not favorable

NECESSITY FOR TRANSPLANTING

Transplanting is not always a necessary operation. Strong 1 or 2 year old seedlings 4 inches or more in height will often succeed under favorable conditions when planted in the field directly from the seed bed. This appears particularly true of loblolly, shortleaf, and slash pines. After one or two years in transplant beds, however, coniferous trees in general are well suited for planting in the field and stand a very good chance of living even if the conditions are not particularly favorable. They are much more likely to live than seedlings on poor, shallow, or infertile soil, or areas covered with brush or heavy long grass, on extremely sandy soils, or on hot, dry exposures such as south and west slopes of hillsides.

AGE AT WHICH TO TRANSPLANT SEEDLINGS

When seedlings reach a height of 3 inches they are large enough to transplant. They will usually be 2 years or more of age, although some will be as tall or taller than this when only 1 year old.

SEASON TO TRANSPLANT

The young trees should be transplanted when growth is dormant, and preferably just before the rainy season commences. This means

early spring in the northern part of the United States, but may mean late fall or even winter in some of the Southern States. Spring transplanting is decidedly preferable in regions of light snowfall which are subject to periods of extremely cold weather during the winter months.

PREPARATION FOR TRANSPLANTING

The first step in transplanting is to put the soil of the transplant area in good tilth by spading and raking. It should be free of sticks and trash, and of rocks if possible. A bed 6 feet wide is a convenient size for working. Assuming a spacing of the plants 2 inches apart in the rows and the rows 6 inches apart, a bed 6 feet wide would have to be about 14 feet long to hold 1,000 transplants. If the rows were 12 inches apart, to permit cultivation with an ordinary hoe, the bed would of course have to be about 28 feet long.

After the transplant beds are prepared, the soil should be well watered. The seedlings should then be dug from the seed beds and carried to the transplant area. In digging, every effort should be made to get well under the roots to avoid breaking them. The greatest of care must be exercised to keep the roots from becoming

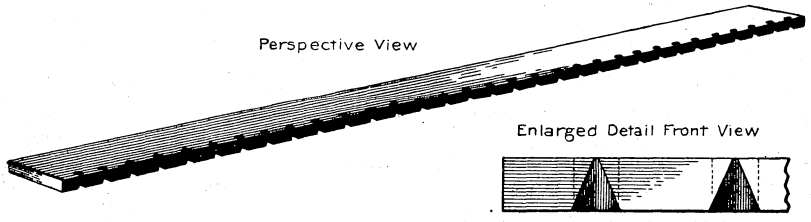

FIG. 24.—Transplant board

dry, because a few minutes' exposure, particularly on a hot, windy day, will often dry up the sap in the roots and kill the young trees. Although the tops may still appear perfectly fresh, any subsequent effort spent in transplanting will be wasted. It is preferable, therefore to do the transplanting on cloudy, cool, calm days, to dig the seedlings only a few at a time as they are needed, and to keep the roots covered with damp soil, damp moss, or damp cloth until the plants are set in the transplant beds.

THE TRANSPLANTING OPERATION

The operation itself is not difficult. One of the simplest means is to use a board 1 inch thick, 6 inches wide, and 6 feet long. Evenly spaced notches should be cut along one edge to hold the seedlings. (Fig. 24.) The board is laid flat on the ground across the bed with its unnotched edge along the line where the first row is to be transplanted. A trench 6 inches or more deep, with its vertical side along the edge of the board, is then excavated. (Fig. 25.) As the soil is removed it is placed directly in front of the trench for use later. The board is then reversed, so that its notched edge projects slightly beyond the vertical face of the trench. The small seedlings are strung upright, one in each notch, so that the lower leaves rest on

the upper surface of the board and the roots rest along the vertical face of the trench and hang toward the bottom. (Fig. 26.) The loose dirt removed in making the trench should be pulled in and tamped firmly around the roots. An inch board 6 to 8 inches long serves well for that purpose. The transplant board should then be disengaged from the tops of the seedlings by tipping it forward on the notched edge and drawing it slowly backward. The same process should be followed with the next row, and so on until the transplanting is done. With a little practice a man can transplant several thousand plants a day. It is advisable to give the beds a good soaking with water at the end of each day's transplanting. This settles the soil around the roots, helps the plants to recover from the shock of transplanting, and is a partial insurance against heavy losses.

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FIG. 25.—Digging a trench along the edge of a transplant board

CARE OF TRANSPLANTS

Transplants generally need little care other than weeding, watering in dry weather, or shallow cultivation in place of watering, and protection against livestock. Where light snowfall and extreme and protracted cold characterize the winters, the young trees may have to be mulched with leaves, hay, straw, or similar material.

LENGTH OF TIME IN TRANSPLANT BEDS

One year is commonly long enough for pines or any other vigorous-growing conifers to remain in the transplant beds, unless they are to be planted where the conditions for growth are unusually adverse. Trees left for two years in the transplant beds generally succeed better on areas covered with a rank growth of grass, bushes, brush, or second-growth timber. Slow-growing species, such as spruces and firs, often require two years in the transplant beds for satisfactory development. Transplants 4 to 6 inches high, with healthy, vigorous, bushy tops and a good bunch of fine roots, are ordinarily large enough and entirely satisfactory for field planting.

STARTING THE PLANTATION

SITES WHERE SUCCESS IS DOUBTFUL

While such species as southern white cedar, northern white cedar, tamarack, southern cypress, and black spruce occur naturally in very swampy areas, it is not suggested that such areas be planted, because too little is known of the probable success which would attend the venture. In Europe, swampy areas are sometimes planted. They are usually drained by ditching, however, or the trees are planted at the apex of mounds of soil, where the roots will not be immersed in water.

A wind-swept seashore is a difficult site on which to secure a satisfactory growth of trees. Only the most hardy species should be planted. Even then the trees nearest the water are extremely likely to be dwarfed and distorted. Native species are ordinarily best

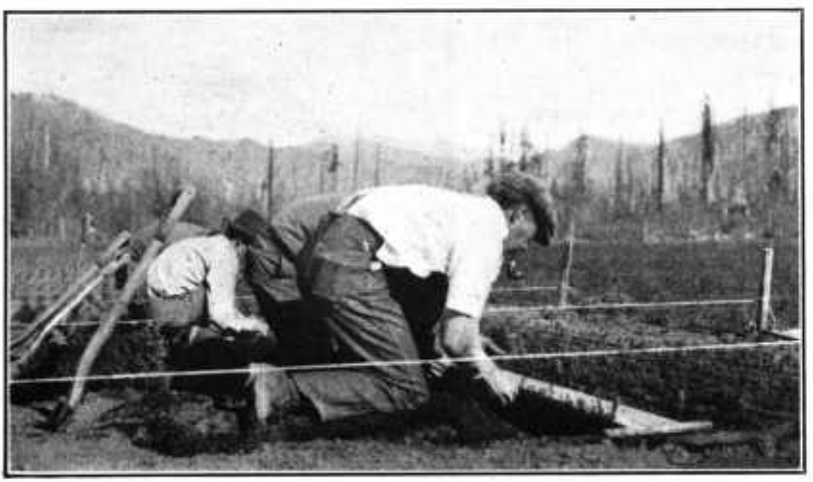

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FIG. 26.—Transplanting seedlings by means of a transplant board. Seedlings are strung in notches at edge of board

adapted to such situations. In Europe, Corsican pine is planted on these exposed sites, and it may do well under these trying conditions in some parts of the United States.

It is inadvisable to plant a site on which a dense young thrifty growth of commercially valuable hardwood seedlings or sprouts, such as oak, ash, birch, maple, yellow poplar, etc., is already present. If such an area is planted to pine, spruce, or other conifers there will be a continuous battle for space and light between the hardwoods and the conifers, and, unless given help in their early years, the conifers are more than likely to be smothered by the falling leaves of the hardwoods, overtopped and shaded out, or whipped out by the hardwood branches. In order to bring the conifers through under such conditions, it will usually be necessary to plant relatively large trees and to cut out the hardwoods from around each planted conifer one or more times at intervals of two or three years. This is a laborious, expensive, and scarcely worth-while undertaking. It is better to let

the hardwoods grow in such situations. Where the hardwoods are rather widely scattered, however, or consist of scrubby or short-lived and scant-foliaged species, such as scrub oak, fire cherry, persimmon, and sassafras, the area may safely be planted to conifers. Brushy and brier-covered areas also can ordinarily be planted with assurance of success. It is usually best under such conditions to plant in the openings rather than to set the trees where they will be densely shaded. Trees do not thrive for any length of time if heavily shaded; they prefer the sunlight.

PLANTING WILD STOCK

A good many plantations of eastern white pine have been started by using wild seedlings dug up in near-by fields or pastures. (Fig. 5.) Some shortleaf, slash, and loblolly pine plantations have been started in the same way. Experience indicates, therefore, that if properly handled it is possible to use such seedlings with success, and the practice could doubtless be extended to other species. Digging the seedlings from the field is ordinarily a rather slow process, and if performed by hired labor, a costly one. Such trees might cost more than trees of equal or better quality for the same purpose purchased from a nursery. Aside from the matter of expense, the wild seedlings do not usually have as good root systems as those grown in nurseries, and unless weather conditions are very favorable after they are planted many are likely to die. Everything considered, the use of wild stock is not generally recommended. However, if the labor cost is not excessive and the wild stock is to be had for the digging, there appears to be no serious objection to using it. The seedlings should be dug rather than pulled, in order to secure as much of the roots as possible, and the roots should be kept moist from the time the trees are dug until they are planted. If available, plants 6 to 8 inches in height should be chosen rather than larger ones, because they will succeed best.

PLANTING LONGLEAF PINE

Longleaf pine is a species that has been planted very little. When 4 to 6 inches tall it has a long, thick taproot which makes successful planting difficult. If longleaf pine seed is gathered as soon as ripe in the fall and sown immediately in a seedbed, it will sprout and make some growth during the same season. It will not develop very much by spring, however. The small seedlings can be dug early in the spring and planted in the field simply by scooping out holes with a shovel, hoe, or garden trowel and setting one plant in each hole. One plantation of which there is record was started in this manner. The method appears to offer the most reasonable chance of success of any planting method so far tried with longleaf pine, although experience with it is limited.

SOWING SEED

As a means of starting a plantation of coniferous trees, sowing the seed directly on the area is a gamble, with small chance of success. In the vast majority of cases where it has been tried in this

country, the method has been a failure, and it is not generally recommended. The seed is eaten by rodents and birds, and seedlings which do start are killed by disease, frost, insects, animals, and drought. Of course some pass through all these dangers and successful plantations occasionally result. There are records of such plantations of white, pitch, longleaf, slash, loblolly, and western yellow pines, and probably other conifers. The method has not yet been given as thorough a trial with southern pines as with northern and western species, and may prove to be more generally successful with them.

Sowing seed broadcast on plowed or thoroughly disked land and then brushing it in with a harrow appears to offer more assurance of success than other methods. At least 1 or 2 pounds of seed should be broadcasted to the acre. Less seed will be required if it is sown in hills or spots spaced 6 or 7 feet apart. The soil in each spot should be dug up and pulverized; several seed should then be sown and covered with one-quarter to one-half inch of soil.

SPACING OF TREES

IN GROVES

In order to utilize the land fully and to promote upright growth, forest trees should be planted rather close together. It is a common practice in the United States to set out 700 to 1,200 trees to the acre. It will be found suitable under most conditions to set out approximately 1,000 per acre. This means they should be spaced about 6½ feet apart.

IN WINDBREAKS

The desirable spacing in windbreak planting will depend largely upon the character of the windbreak. If it is to consist of a single row of trees they should be set out about 4 feet apart. Northern white cedar (arborvitæ) should be spaced 2 feet apart. If of two or more rows, they can be set 6 to 8 feet apart and arranged so that each tree in one row will fall midway between two trees in an adjacent row. A very effective windbreak for the protection of buildings and feed yards will consist of two rows of coniferous trees and then another row about 2 rods distant. The intervening 2-rod space will serve as a trap in which snowdrifts will form rather than to the leeward of the windbreak.

TIME TO PLANT

In regions of severe winters, early spring is generally considered the best season to set trees out in the field. This means just as soon as possible after the frost is out of the ground. Success has attended fall planting in such regions, however, particularly when the snow comes early in the winter and remains late in the spring. Spring planting is also considered essential to success in the arid portions of the Western States, particularly in the intermountain region. If planted in the fall in that region, the foliage of the small plants may be subjected to severe drying by the atmosphere because of the low humidity often prevailing at that time. If the roots are

not well enough established in the soil to supply the foliage with moisture, a condition often made more serious by the freezing of the soil, death of the trees commonly results. In regions of mild and humid winters, planting may be carried on either in the spring or the fall, with admirable chances of success if other factors are favorable. Land should not be planted at any season unless the soil is moist. It is desirable to pick cool, foggy, or drizzly days for planting.

ORGANIZATION OF CREW

For a small planting operation a crew of eight men is a good unit for rapid work. They will set trees on four or five acres each day. If the trees are planted in holes, four of these men equipped with grub hoes will dig the holes; the other four will follow and plant the trees. If the trees are set in slits or clefts, each man makes the slits and plants the trees also. The men with the grub hoes will travel abreast and make the holes 6 to 7 feet apart in a line across the area being planted.

The rows of trees can be kept reasonably straight by lining up poles across the field to which are attached bits of white rags or paper. These can be moved over as the planters come back across the field. There is no need of perfectly straight lines but there is less confusion in planting if they are reasonably straight.

METHOD OF PLANTING

Since forest trees are usually allowed to shift for themselves after they are in the ground, they should be given a good start by careful planting. The roots of pines, spruces, and other evergreens will not stand drying. The plants should therefore be carried in a bucket with the roots immersed in water or thin mud, or in a box or basket where the roots can be covered with wet moss, wet burlap, or similar material. After choosing the spot where a young tree is to be set, the sod or weeds should be scraped off for a space 14 to 16 inches square. A hole should then be dug large enough to accommodate the roots when they are well spread out. The better top soil removed should be placed in a separate pile from the poorer soil, for use later. The seedling should be set in the hole with its roots well spread out, and the better top soil pulled in over the roots and packed down firmly with the closed fist. Loose trash, grass, weeds, moss, etc., should not be pulled in around the roots, since such material can not be packed tightly and will be the cause of the roots drying out and the consequent death of the plant. Additional soil should be pulled in to fill the hole to the ground level and firmed. Then a shallow layer of soil should be drawn around the tree and left loose to act as a mulch.

Where the soil is sandy and free from rocks, planting has been successfully carried on by setting the seedlings in wedge-shaped slits or clefts. These clefts are made by driving a spade or similar tool in the soil to the full depth of the blade and working the handle backward and forward. The roots are then inserted in this V-shaped opening, and the soil is pressed around them with the foot or by again driving the spade in the soil about 4 inches distant and

forcing the soil over against them. Although this method is not so sure as planting in holes, it can be carried on fully twice as rapidly.

If the ground can be plowed before planting, or even single furrows made 6 or 7 feet apart across the field, planting can be carried on more rapidly in the bottom of each furrow and with better prospects of success. The plowing will turn under some of the grass and brush that would otherwise compete with the trees for moisture (fig. 27). In the naturally treeless regions preparations of the soil appears essential for satisfactory results.

One man can ordinarily plant 500 to 1,000 seedlings a day, depending upon the soil, the cover, the day, the man, and other factors. More than 1,000 have often been planted and less than 500.

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FIG. 27.—A tree-planting crew at work in Michigan. Trees can be planted better and more rapidly in furrows

If unplanted trees remain in the pails or baskets at the end of a day's work, the roots should be covered with sufficient water or moss to prevent drying out over night. It is best, however, to dig no more plants from the beds each morning than can be planted during the day.

CARE OF THE PLANTATION

CULTIVATION

In those regions where conifers occur naturally it is unnecessary to cultivate plantations. Where they can be cultivated for two or three years just as corn would be, fewer trees will die and initial growth will be more rapid. In the treeless regions cultivation is essential to prevent heavy losses and to insure satisfactory growth.

LIBERATION CUTTINGS

When coniferous trees are planted in brush or among hardwood sprouts, the hardwoods will often outgrow the planted trees for

several years, and overtop and eventually kill them by crowding or shading. Under such a condition it is necessary to cut back such brush or hardwood growth. This so-called "liberation cutting" should be carried on in midsummer, when the leaves are out. It is easier to determine at that time what brush or sprouts should be cut. Cutting is usually necessary about three years after planting. It may have to be repeated two or three times before the conifers begin to outgrow and reach above the brush or sprouts.

THINNING

When the trees reach an age of 15 to 20 years they will usually crowd each other rather severely and appear to be standing too close together. Some of them will be dead or dying and some will be much smaller than others. The lower limbs will be dead or dying, and a few will have fallen off. These are all good signs; the plantation has developed as it should to produce timber of high quality. There is need at this time, however, to cultivate with an ax—to make a "thinning." The dead and dying trees should be cut and salvaged for cordwood, bean poles, or similar material. Other trees of inferior form which are crowding better trees and any diseased or damaged specimens should also be cut. When a portion of the trees is removed in a thinning, those remaining have more room, light, and moisture, and they respond with increased growth. When thinnings are repeated several times during the life of the plantation, the final result is a stand of large trees of fine quality. In unthinned woods the final result is a stand consisting of some fine, large trees mixed with a considerably larger number of inferior, smaller ones. In making thinnings the crown cover should not be opened to such an extent that a great deal of sunlight will strike the ground under the trees, because this will dry out the soil, give rise to a growth of weeds and grass, and make conditions in general less favorable for the growth of the remaining trees.

PRUNING LIMBS

When trees are planted close together in a body, the limbs of adjacent trees will touch and crowd each other in 7 to 10 years and the shade will gradually kill the lower limbs. Some trees shed dead limbs rather quickly; others retain them, or at least the stubs, for a long time. It is not uncommon for eastern white pine and Norway spruce, for example, to retain the dead stubs of lower limbs up to 50 years of age. Limbs cause knots, and knotty logs are less valuable than smooth logs. When the timber has a high commercial value and when the cost of the operation is not excessive, pruning the limbs from coniferous trees appears to be justified. If, for instance, the owner of such trees can utilize his own spare time to saw off the lower limbs to a height of 13 to 17 feet, when the trees are not yet over 4 or 6 inches in diameter, he will be well repaid for his efforts in the increased value of the butt logs. This has proved true in the case of eastern white pine in New Hampshire. It is best to saw the limbs off as close as possible to the trunk of the tree. The wounds will then heal quickly, and butt logs will be smooth and will saw out a large proportion of clear lumber. None but the most thrifty and rapid-growing trees should be pruned, be-

cause the small and stunted individuals are almost certain to be killed by crowding before they reach saw-log size.

PROTECTION

Trees in plantations are subject to various injuries, some of which are difficult to combat. If rodents, insects, or diseases cause trouble, it is best to seek a remedy through the State forester, State agricultural college, or the United States Department of Agriculture. Special attention should be given to protecting white-pine plantations from the white-pine blister rust[4] and the white-pine weevil.[5] Damage from severe winds, snow, and ice storms may take place, and can scarcely be guarded against. Injury from fire and livestock can and should be avoided. Young coniferous trees are readily killed even by grass and leaf fires. Larger trees are often severely burned and are later attacked by diseases or insects through the fire-caused wounds. Such trees lose a great deal in value from the deterioration of the butt log. Every reasonable means should be taken, therefore, to keep fire out of a plantation. A fire of short duration will undo the work, care, and expenditure of a number of years. Vigilance should be used to detect and suppress any fires that occur in or near a plantation. A fire line may be constructed around the plantation if it is possible to do so. A fairly effective fire line can be made by plowing a strip 8 or 10 furrows wide entirely around the plantation or along those sides from which fire may come. If kept clean, such a fire line will stop an ordinary leaf or grass fire or will make it possible to halt the fire there.

Horses, cattle, and sheep often do considerable damage to young conifers by trampling and browsing, and in fly time by brushing against and breaking them; hogs root up the soil and small trees. Any of these animals injure the older trees by trampling and packing the soil around the roots, thus shutting off the air and water supply and even exposing and skinning the roots themselves. This often causes the gradual dying of the tops. Damage of this sort is usually serious only when the woods are heavily pastured or when the ground is very soft. There are times when it may even be advantageous to turn sheep in a plantation where conifers are set among hardwood brush or sprouts. Sheep prefer to browse on the hardwood leaves and twigs, and when hardwoods are browsed off the conifers have a better chance to develop. Except to accomplish that purpose, livestock has no place in a well-cared-for plantation.

GROWING CHRISTMAS TREES

Every year several million coniferous trees, varying in height from 1 to 15 feet or more, help to make the Christmas season a festive one. The greater number are probably 4 to 8 feet tall. Many come from the hillsides and pastures of farms, particularly those of the Northern States, where spruce and firs, the trees most cherished for the purpose, occur in greatest abundance. In 1924,

[4] Full information as to methods can be procured from the Office of White Pine Blister Rust Control, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

[5] Information in regard to the white-pine weevil may be had from the Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

spruce and fir trees commonly sold for $1 to $3 and more on the streets of the larger eastern cities. Retail prices have increased several hundred per cent in the last 15 or 20 years. High prices appear likely to prevail in the future, and in consequence growing Christmas trees in plantations near the large consuming centers is beginning to look like an attractive business proposition. This is particularly true for centers in the Eastern and Middle Western States which are rather distant from a natural source of supply. Several such plantations are already in existence, from which trees have been sold at prices ranging from 50 cents to $1.50 each (fig. 28). In a plantation adjacent to a good public road it seems probable that all trees could be sold right on the ground to people passing in automobiles.

Christmas trees should be given more care than the ordinary forest plantation. The trees should be set out on land prepared by

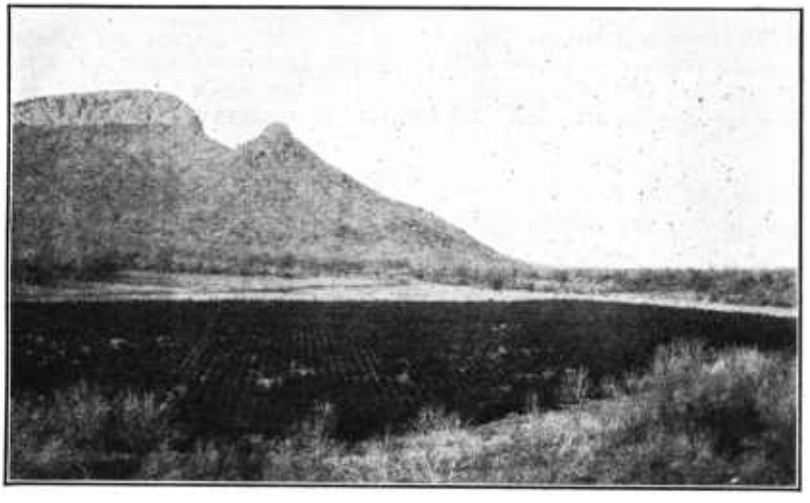

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FIG. 28.—Nine-year-old red cedar plantation in Comanche County, Okla., from which Christmas trees have been sold on the ground for 75 cents to $1 each.

plowing as for any field crop. After the trees are planted they should be cultivated for two or three years in the same way that corn is cultivated. Since the trees will be grown for only 5 to 8 years and in no case perhaps over 10 years after they are set out, they can be planted at the rate of about 5,000 per acre. A triangular spacing of 3 by 3 feet will mean about 5,600 per acre.

The trees will not all grow at a uniform rate. It will be possible to harvest some in 4 or 5 years after planting, and others in each succeeding year. Excessively rapid growth should not be sought, for slower-growing trees are more compact and better liked for Christmas-tree use.

In the region east of the Rocky Mountains, the trees likely to command the highest prices are the spruces and firs. These can not be grown everywhere, but where they can (as indicated in fig. 4) they are the logical choice for planting. If Norway spruce is adapted to the locality, it is preferable to other spruces listed, be-

cause it grows more rapidly. In those Southern States where small native pines are very plentiful and commonly used for Christmas trees, it is doubtful if plantations would at present yield satisfactory financial returns. The same is probably true for the region from the Rocky Mountains to the Pacific coast, where coniferous trees are either abundant locally or can be shipped in from a short distance.

In starting a plantation of this character, it seems desirable to use good sturdy trees, preferably transplants about 4 years old. They will take hold readily and begin to grow the first year. Small, weak trees, on the other hand, will be slow to start and will require 2 or 3 years longer than transplants to reach a salable size.

Results gained in a plantation of red cedar in western Oklahoma, where red cedar grows better than other conifers, indicate that at least two crops of Christmas trees may sometimes be secured from one setting of trees. When the first crop was harvested in this plantation, the trees were cut off just above the large lowest limbs. All but the strongest one of these limbs was then cut. In the course of a year or two this limb assumed an upright growth and a few years later another Christmas tree resulted. Whether or not this practice will succeed with all species of conifers is unknown.

APPENDIX

State forestry departments, April 25, 1925

State	State forester or similar officer
Alabama	State forester, Montgomery.
California	State forester, Sacramento.
Colorado	State forester, Fort Collins.
Connecticut	State forester, Hartford.
	Forester of the agricultural experiment station, New Haven.
Idaho	State forester, Boise.
Illinois	State forester, Urbana.
Indiana	State forester, Indianapolis.
Iowa	Forester of the Iowa Agricultural College, Ames.
	State forestry commissioner, Des Moines.
Kansas	State forester, Manhattan.
Kentucky	State forester, Frankfort.
Louisiana	Superintendent of forestry, New Orleans.
Maine	Forest commissioner, Augusta.
Maryland	State forester, Baltimore.
Massachusetts	State forester, Boston.
Michigan	Director, department of conservation, Lansing.
Minnesota	State forester, St. Paul.
Montana	State forester, Missoula.
New Hampshire	State forester, Concord.
New Jersey	State forester, Trenton.
New York	Superintendent of State forests, Albany.
North Carolina	State forester, Raleigh.
North Dakota	State forester,[6] Agricultural College.
Ohio	State forester, Wooster.
Oregon	State forester, Salem.
Pennsylvania	Secretary, department of forests and waters, Harrisburg.
Rhode Island	Commissioner of forestry, R. F. D., East Greenwich.
South Dakota	Forest supervisor, Custer.
Tennessee	State forester, Nashville.
Texas	State forester, College Station.
Vermont	Commissioner of forestry, Montpelier.
Virginia	State forester, Charlottesville.
Washington	State supervisor of forestry, Olympia.
West Virginia	Chief game protector, Buckhannon.
Wisconsin	Superintendent State forests and parks, Madison.

[6] Position designated by governor; not provided for by law.

States which maintain forest tree nurseries and are authorized to distribute small trees to any resident of the State for forest planting

[Address State Forestry Department (as above), unless otherwise indicated]

Maine.
New Hampshire.
Vermont.
Massachusetts.
New York.
Pennsylvania.
Idaho (address University of Idaho School of Forestry, Moscow).
Maryland.
Virginia.
Louisiana.
Ohio.
Michigan.
Wisconsin.
Kansas.
Indiana.
Washington (address State College of Agriculture, Pullman).
Colorado and New Jersey distribute trees but do not maintain nursery.

Some U. S. Department of Agriculture forestry bulletins of interest to farmers and available free upon request

Farmer's Bulletin No.	Title
744	The Preservative Treatment of Farm Timbers.
1071	Making Woodlands Profitable in the Southern States.
1110	Cooperative Marketing of Woodland Products.
1117	Forestry and Farm Income.
1123	Growing and Planting Hardwood Seedlings on the Farm.
1177	Care and Improvement of the Farm Woods.
1210	Measuring and Marketing Farm Timber.
1256	Slash Pine.
1312	Tree Planting in the Great Plains Region.
1405	The Windbreak as a Farm Asset.

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June 25, 1925

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